Instruction Manual
21-050Ja

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for the use of

Major™ Megger® Insulation Testers

Catalog Numbers 210159, 210259, 210359, 210459, 210559, 210160, 210170, 210189.

Biddle Instruments

BLUE BELL, PA. 19422

Operating and Service Manual
21-050Ja

for

MAJOR MEGGER INSULATION TESTERS
CATALOG NUMBERS 210159, 210259, 210359, 210459
210559, 210160, 210170, 210189

WARNING!

- **MISUSE OF HIGH VOLTAGE EQUIPMENT CAN BE EXTREMELY DANGEROUS.**
- **READ THE INSTRUCTION MANUAL FOR PROPER USE.**
- **SAFETY IS THE RESPONSIBILITY OF THE USER.**
- **EQUIPMENT TO BE TESTED MUST BE DISCONNECTED FROM POWER.**
- **ALL PERSONNEL MUST BE KEPT CLEAR OF BARE LIVE PARTS.**
- **FOLLOW ALL OTHER SAFETY PRECAUTIONS.**

UL Listed

BIDDLE INSTRUMENTS
Blue Bell, PA 19422

4/85

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Section A
INTRODUCTION

The MAJOR MEGGER® Insulation Testers are designed to measure insulation resistance up to 20,000 megohms and down to 10 kilohms, the flow of current through and/or over the surface of electrical wiring and equipment insulation. The test results are used to detect the presence of dirt, moisture and insulation deterioration. The instruments measure up to 5,000 ohms and down to 1 ohm to check the continuity and integrity of conductors and connections. Also, an alternating voltage range of 0 to 600V rms is provided for determining the presence and magnitude of unexpected voltage before other testing is done.

MAJOR MEGGER Testers may be powered by an internal hand-cranked ac generator, an internal line power supply, and primary or rechargeable cells. Also, combination units are powered by the generator/line power supply; or the line power supply/rechargeable battery. The output test voltage is selectable on four megohm ranges. The maximum dc test voltage on the ohms range is 6 volts. The six-position selector switch is marked from the CCW position as follows: VOLTS/DISCHARGE, four Megohm ranges - highest to lowest, and Ω. (See the specification table for the ranges of the specific model).

Figure 1: Cat. No. 210159 MAJOR MEGGER Tester Shown with optional Cat. No. 217720 Case and optional Cat. No. 21963C Leads (6 ft).

Section B
SAFETY PRECAUTIONS

SAFETY IS THE RESPONSIBILITY OF THE USER

This test set and the test sample to which it is connected are sources of high-voltage electrical energy. All persons performing or assisting in a test must use all practical safety precautions to prevent contact with energized parts of the test equipment and associated circuits. Persons actually engaged in the test must stand clear of all parts of the complete high-voltage circuit unless the test set is de-energized and all parts of the test circuit are grounded. Any persons not directly associated with the work must be kept away from test activities by suitable barriers, barricades, or warnings.

High-voltage test equipment, as well as the equipment to be tested, should be enclosed in an interlocked area.

If the test set is operated properly and all grounds are correctly made, test personnel need not wear rubber gloves. As a routine safety procedure, however, some users require that rubber gloves be worn, not only in making connections to the high-voltage terminals, but in manipulating the controls. BIDDLE Instruments considers this an excellent safety practice.

Section C
RECEIVING INSTRUCTIONS

When your BIDDLE MAJOR MEGGER Insulation Tester arrives, check the equipment received against the packing list to ensure that all materials are included. Notify BIDDLE Instruments, Blue Bell, PA, of any shortage of materials.

Examine the equipment for damage received in transit. If any damage is discovered, file a claim with the carrier at once and notify BIDDLE Instruments or its nearest authorized sales representative. Be sure to include a detailed description of the damages observed.

This equipment has been thoroughly tested and inspected to meet rigid inspection specifications before being shipped. It is ready for use when set up as indicated in Section F.

Section D
SPECIFICATIONS

ELECTRICAL

TABLE 1: MEGOHM RANGE

CAT . NO.	RESISTANCE RANGE, MΩ	MAX VOLTAGE, VOLTS ±2%	MIDSCALE, MΩ
210159, 210259, 210359, 210459, 210559	0 to 2000	1000	20
	0 to 1000	500	10
	0 to 500	250	5
	0 to 200	100	2
210160	0 to 1000	500	10
	0 to 500	250	5
	0 to 200	100	2
	0 to 100	50	1
210170	0 to 20,000	1000	200
	0 to 10,000	500	100
	0 to 5,000	250	50
	0 to 2,000	100	20
210189	0 to 200	100	2
	0 to 100	50	1
	0 to 50	25	0.5
	0 to 20	10	0.2

Short Circuit Current: 450 μA on all models and all ranges except 210170 which is 45 μA on all ranges.

Test voltage regulation:

The test voltage applied to the load at the center scale indication is 90% of maximum for any range and any instrument. (See Fig. 2).

Accuracy:

±0.03 inches (0.76 mm) on a 3.08 (78.2 mm) inch arc length. This is equivalent to ±10% of reading at 15% and 85% of full scale indication and ±5% of reading at the midscale indication.

Ohms:

Resistance Range: 0 to 5,000Ω at 6V;
the center scale reading is 100 Ω,
the short circuit current is 60 mA.

Accuracy: ±0.03 inches (0.75 mm) on a
3.05 inch (77.5 cm) arc length.

Voltage:

Voltage Range: 0 to 600V ac ±3% or 0 to ± 540 dc
±3 % (ac ÷1.11).
The meter is rms calibrated and average-responding.

Maximum Load Capacitance: 1 µF with less than ±0.1 inch pointer movement.

Discharge: Up to 1 µF capacitance is discharged from 1000V to less than 42.4V in less than 2 seconds (per ANSI-C39.5).

Withstand Voltage: 2500V, 60 Hz, 1-minute test between the internal circuits and a conductor on the outside of the case, per IEC 348 Class I.

The instrument will measure the resistance of up to 1 μF capacitive load with stated accuracy because of the well-regulated internal supply. This type load can be easily discharged by switching to the VOLTS/DISCHARGE position. The progress of the discharge can be followed on the meter.

Operating Temperature Range: 32° to 113°F (0° - 45°C) for battery powered models. 32° to 149°F (0° - 65°C) for other models.

Vibration/Shock: 0.02 inches (total excursion) 10-50 Hz or 50 g. 10 times on each of 3 perpendicular planes (per ANSI-C39.1) and 0.062 inches (total excursion) 10-35 Hz (per MIL-O-16485C) still within specifications. 3 ft. drop on concrete on each face and corner, still operational.

Humidity: 3 cycles of six hours at 65°C and 90% RH followed by 24 hours recovery at 20°C ±5°C and <60% RH. No measurable degradation (per MIL-O-16485C).

Power Supplies:

Catalog No. 210159, 210160, 210170, 210189:
Hand-cranked Generator.
Minimum cranking speed of 120 rpm is required to keep "LOW SUPPLY" light out.

Catalog No. 210259
Integral line transformer and rectifier circuit.
120V +10%, -15% at 50/60 Hz.
Power line burden 6 VA
Input - CEE-22 Appliance Inlet Connector per CEE Pub. 22.

Catalog No.210359
Dual operation - Hand crank generator and integral line operated power supply. Specification as applicable from Cat. Nos. 210159 and 210259.

Catalog No. 210459
Battery operation only.
(Battery terminals ANSI No. XVII).

TABLE 2: RECOMMENDED BATTERIES (in order of suitability)

CAT. NO.	SIZE			NO. REQ	TYPE - MANUFACTURER RECOMMENDED IN ORDER
	NEDA	ANSI	IEC		
210459	15A	L40 AA Size cell	LR6-cell	6	Alkaline: Duracell MN 1500 Eveready, E91
	15	AA Size	R6-cell	6	Zinc - Carbon: any cell
	1604A Batt.	-	6LF22	1	Alkaline: Duracell MN1604 only

Catalog No. 210559
Dual operation - internal line operated power supply, charging circuits, and rechargeable batteries. Specifications as applicable from Cat. No. 210259.

Note: Catalog No. 210559 uses rechargeable nickel-cadmium batteries. These batteries are not user replaceable. Refer to service section for more details.

PHYSICAL CHARACTERISTICS

Dimensions: (All units):

Length: 7.0 inches (177.8 mm)

Width: 4.5 inches (114.3 mm)
6.0 inches (152.4 mm) including the handle.

Height: 5.0 inches (127 mm)

Weight: approximately 4.5 pounds, (9.9 kg) (depends on specific model.)

Test Leads: Black and Red, 6 ft. or 12 ft., AWG 18 terminated in "crocodile" style clips are available.
Cat. No. 21963C (6 ft)
Cat. No. 21963B (12 ft)

MISCELLANEOUS

All testers are designed to conform to ANSI-C39.5, and IEC 348 for safety considerations and to MIL-O-16485C for overall quality.

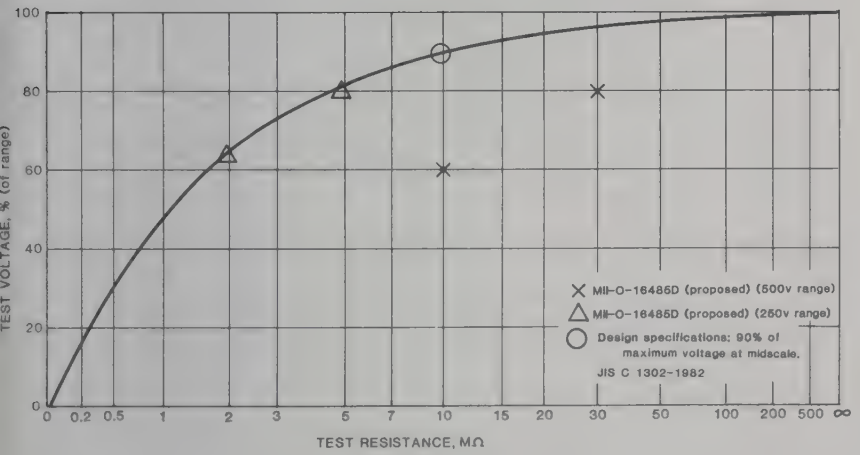


Figure 2: Cat. No. 210159 Series Typical Voltage Characteristics.

Section E
DESCRIPTION

The MAJOR MEGGER® tester is portable and is enclosed in a molded, impact-resistant flame-retardant case which stands on four rubber feet. Test leads and a vinyl carrying case are available for the instrument. The meter movement is calibrated directly in megohms, ohms, and AC volts and is mounted in the top of the two-piece case. The range and/or function of this instrument is selectable by a switch mounted on the top surface marked VOLTS/DISCHARGE, four megohm ranges highest to lowest, and Ω.The scale is viewed through a transparent window. Test terminals are provided on the top surface and are marked COM, V-MΩ-Ω and GUARD. When supplied, the AC generator is driven by a hand crank through a gear train. The folding crank for the generator is mounted on the right side of the case. When a line power unit is supplied, the power cord plugs into an inlet located on the end of the case. The battery access cover is on the side of the case.

The dual-operated instruments have a toggle selector switch mounted in a protected location on the front surface. The instrument is all electronic; generating a regulated dc high voltage and employing low zero drift, high accuracy scale shaping circuits, with high current sensitivity. A rugged high-torque taut-band meter movement is used. A LOW SUPPLY light is designed to warn of impending battery exhaustion or low supply voltage. Under normal conditions (i.e. good batteries, proper cranking speed or adequate line voltage) the LOW SUPPLY light will be out. Accurate readings may be taken while this light is on steadily. When the light is flashing and indicating inadequate supply voltage, the meter indication will be unstable, thus preventing an erroneous reading. When switched to the Megohm or Ohm range, no light and no meter indication with a short circuit at the input terminals shows that the batteries are exhausted or that the

supply voltage is very low. When a hand-cranked ac generator supplies the power, the light condition will show when sufficient cranking speed is attained. Also, the light monitors the line power supply output and will indicate low voltage conditions.

An internal fuse protects the Ω function from inadvertant application of AC or DC from supply lines. The fuse is accessible for replacement by removing four screws located on the bottom of the case. A spare fuse is located internally.

WARNING - All test leads and line cord must be removed before attempting to remove the bottom cover.

WARNING - FOR CONTINUED PROTECTION AGAINST FIRE, REPLACE FUSE ONLY WITH 250V, 1A FAST ACTING TYPE (AGC-1).

Section F
OPERATION

Because the MAJOR MEGGER® tester is a portable instrument used only for testing purposes, no special installation is necessary. The instrument will operate in any position, but the stated accuracies can be achieved only when the unit is on a firm level surface. This is especially necessary for the generator powered units in order to obtain a smooth constant cranking speed.

PERFORMANCE CHECK

On receipt of the instrument or at any time it is thought necessary, an inspection may be performed to check the operation of the unit as follows:

1. Check 0 (zero) megohms. With the test leads connected to COMMON and V-MΩ-Ω and the ends shorted together, select an appropriate megohm range and energize the instrument. The LOW SUPPLY light should be out and the pointer should not be more than 0.030 inches away from 0.

2. Check ∞ (infinity) megohms. With the test leads connected to COMMON and V-MΩ-Ω and twisted together and the ends separated by 3 or more inches, select the highest voltage range and energize the instrument. The LOW SUPPLY light should be out and the pointer should not be more than 0.030 inches off ∞ . If the unit fails this test, retest without the leads. If the unit passes, replace the leads.

3. Check ∞ and 0 on all other ranges. With the instrument energized, each of the other MΩ ranges, and the Ω range, may be checked as outlined in Steps 1 and 2.

4. Check AC VOLTS. It is not necessary to energize the instrument to read voltage; this is a purely passive circuit. Switch the instrument range to VOLTS/DISCHARGE and connect the leads to the COMMON and V-MΩ-Ω terminals and to a source of ac voltage of known value, such as 120V. The meter should indicate approximately the correct voltage.

(See Manual 21-P-8a "A Stitch in Time...", for other instructions.)

USE.

The instrument is to be used in checking the insulation resistance of electrical installations and apparatus. These tests are to be made for acceptance and test of apparatus, for maintenance checks, or to determine faulty wiring.

CAPABILITIES

The instrument is designed to make insulation resistance tests within the resistance range shown for the model selected in the SPECIFICATIONS section.

The potential applied to the apparatus under test will vary from zero to maximum voltage depending on the resistance of the item being tested and the internal resistance of the instrument that is in series with the COMMON terminal, (see Figure 2).

CAUTION!

DO NOT USE INSTRUMENT ON APPARATUS FOR WHICH THE MAXIMUM TEST VOLTAGE IS UNSAFE

TEST LEADS.

The test leads available with the instrument are 6 feet long, however, 12 foot lengths are also available. DO NOT INTERCHANGE TEST LEADS WITH THOSE FROM OTHER INSTRUMENTS OR USE THE LEADS SUPPLIED FOR OTHER PURPOSES. The leads have been designed for use with this instrument. Any substitutions may cause errors in reading or be dangerous to the operator. Use spring clips for connecting the test leads to the apparatus or circuit under test.

PREPARATION FOR USE.

Before using instrument, check zero and infinity and check test leads. Follow procedure outlined.

PREPARING APPARATUS TO BE TESTED.

1. Shut down apparatus to be tested.
2. Open switches.
3. De-energize.

WARNING!

WHEN TAKING APPARATUS OUT OF SERVICE, BLOCK OUT DISCONNECT SWITCHES, APPLY NEUTRAL OR PROTECTIVE (WORKMAN'S) GROUNDS

4. Disconnect apparatus to be tested from other equipment and circuits. Avoid removing protective grounds by disconnecting the apparatus from the exposed bus or line, leaving the latter grounded.
5. If neutral or other ground connections must be disconnected, be sure they are not carrying current at the time, and that when disconnected all other equipment will have necessary protection.
6. Inspect conductors which lead away from the apparatus to be tested to be sure that they have been disconnected properly from any source of voltage.

7. Inspect apparatus to be tested to determine what equipment is connected and will be included in the test. The more equipment included in the test, the lower the reading. The true insulation resistance of the apparatus under test may be masked by the insulation resistance of the related equipment.

8. It is good practice to use the DISCHARGE/VOLTS function first to be certain that the circuit to be tested is de-energized. The DISCHARGE/VOLTS function is intended only to indicate the presence of an unexpected voltage or to monitor the progress of discharge. It will indicate if the unexpected voltage is ac or dc, but with no polarity indication. Always treat every circuit as energized and charged until you prove it is not energized.

9. The capacitive effect on readings will cause the meter to settle slowly to the final value of resistance. Be sure to wait until the pointer stops moving! If re-test is required the apparatus under test should be discharged for 4 times the length of the initial test time to ensure accurate readings, i.e., if test requires a period of one minute, then discharge for 4 minutes.

10. When apparatus is shut down for the insulation resistance test, make sure that the readings are not affected by leakage over or through switches or fuse blocks, etc. Such leakage may cause inaccurate test results. Inconsistent readings can be caused by current leaking from an energized line into the apparatus, particularly if the live line is direct current. Such leakage can be detected by watching the ohmmeter pointer at the moment the test leads are connected to the equipment to be tested.

CONNECTIONS.

(See details in Manual 21-P-8a; the use of the GUARD terminal is treated extensively).

Section H
OPERATOR MAINTENANCE

The MAJOR MEGGER Tester is conservatively designed using industrial grade electronic parts and for this reason does not require periodic maintenance or recalibration. In the generator powered version the gear train and bearings have been permanently lubricated and no additional lubrication is required.

Of course, in the primary cell powered version, the battery requires occasional replacement, depending upon the amount of use. The rechargeable cell powered version can be completely recharged by plugging the unit into line power for 16 hours.

WARNING!

TO AVOID ELECTRICAL SHOCK, DISCONNECT ALL LEADS BEFORE REMOVING BATTERY COVER.

An internal fuse (AGC-1) protects the Ω function from inadvertant application of AC or DC from supply lines. The fuse is accessible for replacement by removing four screws located on the bottom of the case. A spare fuse is located internally.

WARNING - All test leads and line cord must be removed before attempting to remove the bottom cover.

WARNING - For continued protection against fire, replace fuse only with 250V, 1A fast acting type (AGC-1).

Section J
WARRANTY & REPAIR

All products supplied by BIDDLE Instruments are warranted against all defects in material and workmanship for a period of one year following shipment. Our liability is specifically limited to replacing or repairing, at our option, defective equipment. Equipment returned to the factory for repair will be shipped Prepaid and Insured. The warranty does not include batteries, lamps or tubes, where the original manufacturer's warranty shall apply. WE MAKE NO OTHER WARRANTY.

The warranty is void in the event of abuse or failure by the customer to perform specified maintenance as indicated in this manual.

REPAIRS

BIDDLE Instruments maintains a complete instrument repair service. Should this instrument ever require repairs we recommend that it be returned to the factory for repair by our instrument specialists. When returning instruments for repairs, either in or out of warranty, they should be shipped Prepaid and Insured, and marked for the attention of the Instrument Service Manager.

Section K
SYMBOL GLOSSARY

The following is a glossary of symbols used for marking instruments and accessories per IEC Publication 51. The explanations are written for clarity of meaning and may not be precise in every technical detail. Please consult the International Electro-technical Commission Publication 51 for precise definitions.

Refer to the Instruction Manual or a separate document.

This is a safety specification defining the withstand voltage from the circuitry inside the case to the user's body. It is stated in kilovolts. The symbol shown indicates a test voltage of 2,500 volts, 60 Hz.

Instrument is to be used with the scale or dial in a horizontal plane for stated accuracies.

Electronic devices are used in the measuring circuit.

K

(Not an IEC specification.) A Japanese specification, JIS-C-1302-1982, symbol which indicates the use of a regulated power supply.

A permanent-magnet moving-coil instrument is used as the indicator.

A rectifier is used in the measuring circuit.

A direct current circuit with an accuracy as shown based on a fiducial or full scale deflection. In the case of the megohmmeter this is a mechanical deflection accuracy.

An alternating current circuit with an accuracy as shown based on a fiducial or full scale deflection.

Section L
SERVICE

WARNING - THE FOLLOWING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO REDUCE THE RISK OF ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

CIRCUIT DESCRIPTION (Refer to Figures 3 through 7 Schematic Drawings)

A circuit description is included here to clarify the operation of the instrument and will be of help if service is required.

1. The first important circuit is the instrument measuring circuit R11, which is composed of a voltage divider and three series resistors which set the open circuit voltage and short circuit current for each of the four ranges in the megohm measuring mode (MΩ). The resistor network package also contains a feedback voltage divider to provide a signal to the voltage regulator. So, in effect, the measuring circuit is a highly regulated high voltage supply with various voltages available from the precision voltage divider and series resistors which determine the internal impedance of the source at each selected voltage output.

   Notice that at center value on the megohm scale there is 90% of the output voltage available as shown on the Voltage Characteristics Curve in Fig. 2. The ohmmeter section (Ω) is very similar; the open circuit voltage is a well regulated 6 volts. This is set by the relationship between this supply and the high voltage supply. The regulated 6 volt supply and a series of resistors provide 100 ohms as a center value of the ohmmeter scale. The ohmmeter is a simple reciprocal scale, so that at 100 ohms the voltage across the test sample (or apparatus) is 3 volts, or one half of the supply.

2. The second part of the circuit is a dc-to-dc inverter; Q2, Q3, T1 and a high voltage supply. This uses the 6 volt supply and transforms it by means of a switching circuit (running at about 3 kHz) to high voltage. The output of the inverter transformer is full wave rectified and doubled.

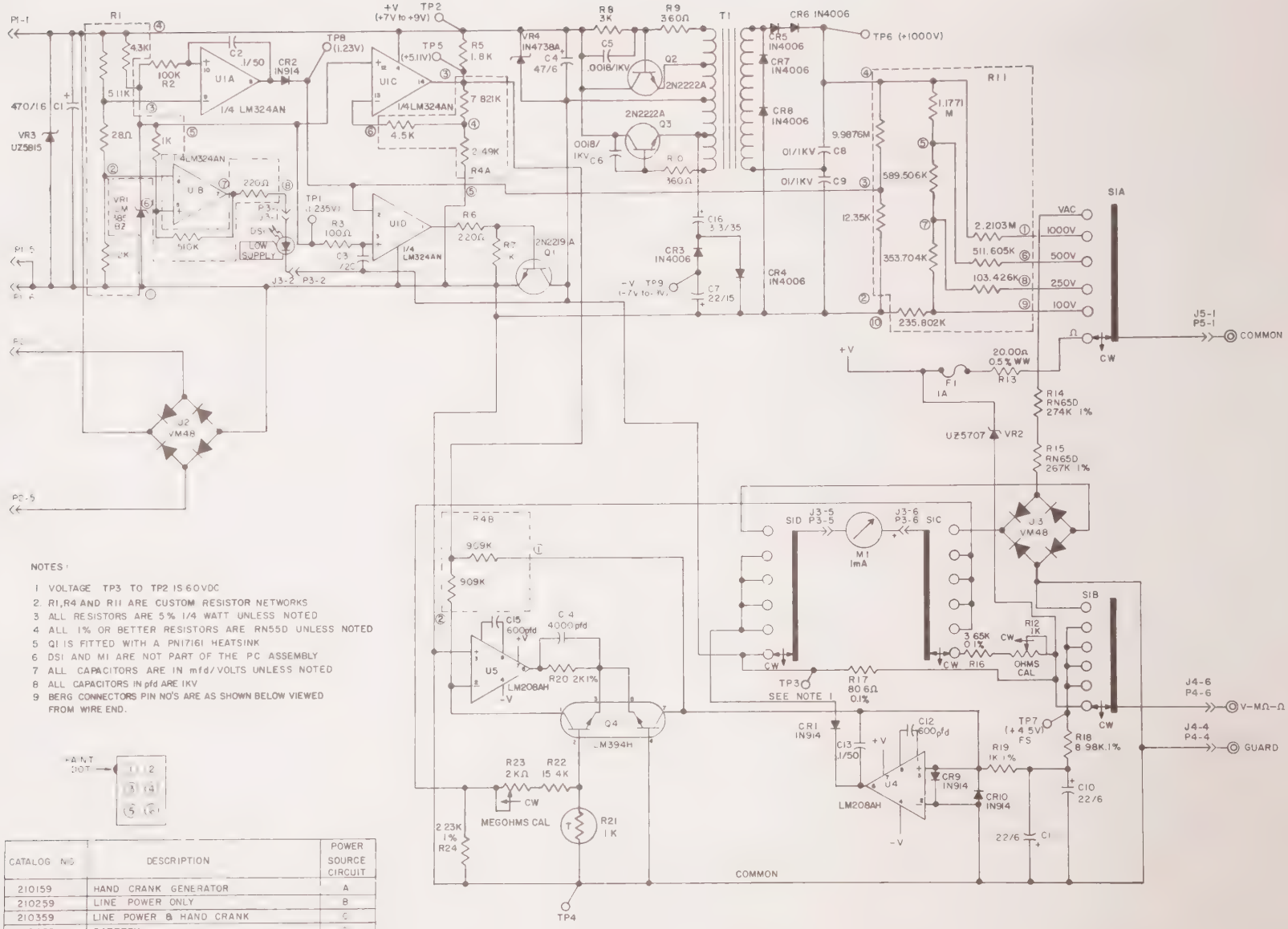
3. The D section of the quad-operational amplifier U1 is used as a voltage regulator, together with transistor Q1, which is used as a series pass element. The voltage reference is derived from the voltage regulator VR1 and compared against the feedback signal from the divider as described before.

4. In order to provide a log scale compression, a current biased logarithmic converter is used. This is composed of two operational amplifiers, U4 and U5, and a pair of matched transistors Q4 with a temperature compensating resistor R21 included. The output voltage of this composite circuit is proportional to a modified logarithm of the input current. This logarithmic response is obtained from a special characteristic of the transistors and has a 60 millivolts per decade change in input current. Also as part of this circuit is an input filter C10 and C11 included to reduce to negligible proportions any alternating current that might be fed into the input circuits. This prevents errors from the resultant rectification.

5. A fifth circuit provides a combination of power supply condition, measurement and control, as well as a voltage reference for the log converter. It uses the remaining three amplifiers in the quad-operational amplifier U1. The A section is the control amplifier which intermittently shuts off the

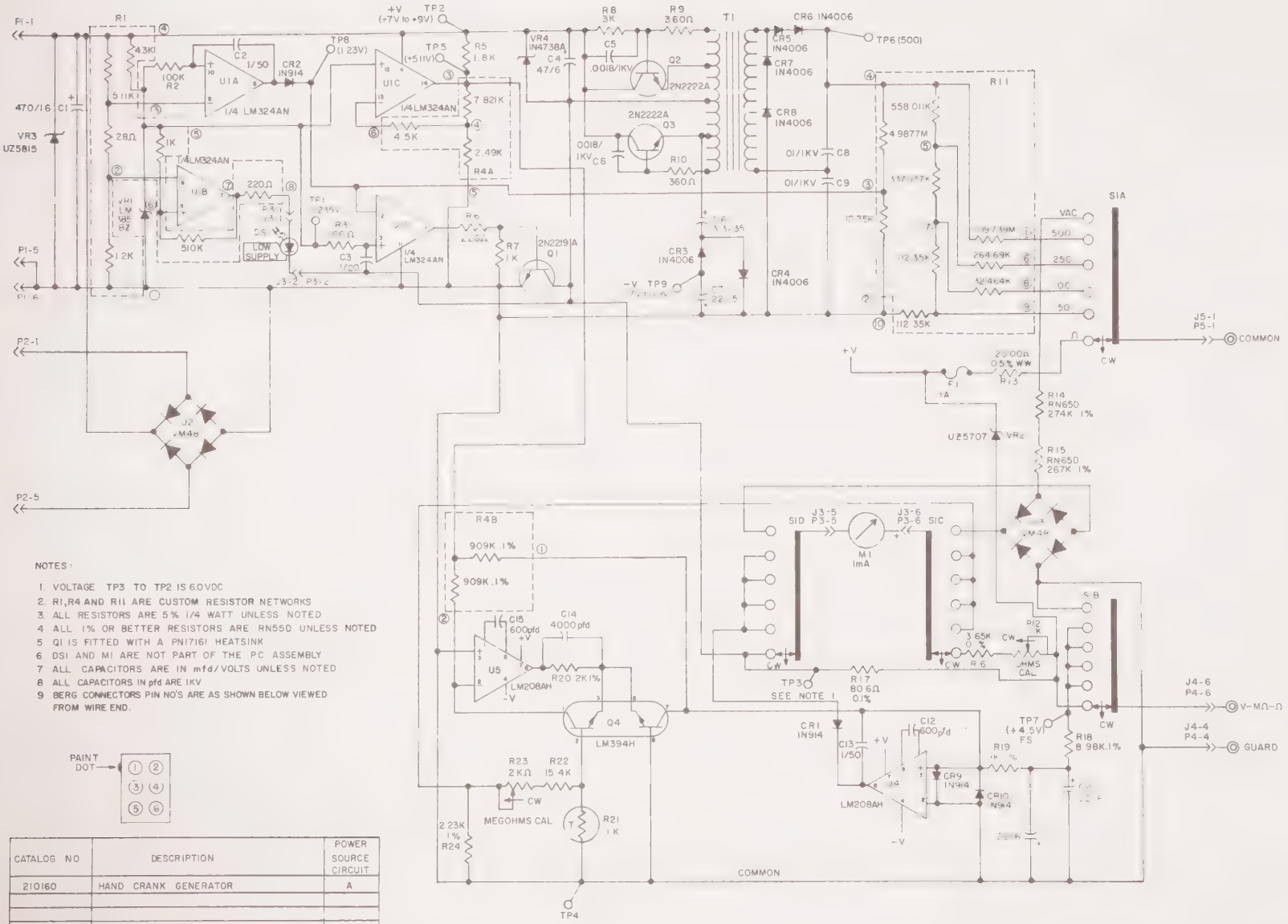
regulator when a low supply condition is reached and to finally shut off the regulator entirely when the voltage is too low to operate the circuit with stated accuracy. The B section of the operational amplifier provides a warning at a level sufficiently above the voltage which causes inaccuracy. The warning is in the form of an LED DS1, located in the lower left hand corner of the meter scale. The C section of the operational amplifier and several resistors in the resistor network package form a biasing current into the two inputs of the logarithmic converter. This causes a compression in the left hand side of the megohmmeter scale. A compression which is geometrically similar on the right hand side of the scale is achieved by selection of the series resistances in the megohm ranges.

6. The remaining circuits are the ac voltage (AC VOLTS) measurement circuit which is simply two series resistors and a bridge rectifier to provide an rms indicating and averaging responding meter. This is totally passive for safety and reliability reasons. Also, the network will discharge any capacitance connected to the input terminals of the instrument. It is recommended that this range be used first for personnel and equipment safety reasons to determine the presence of unexpected voltages before the insulation test is made. Also, this function will discharge any capacitance that might be present.



CATALOG NO	DESCRIPTION	POWER SOURCE CIRCUIT
210159	HAND CRANK GENERATOR	A
210259	LINE POWER ONLY	B
210359	LINE POWER & HAND CRANK	C
210459	BATTERY	D
210559	LINE POWER & RECHARGABLE BATTERY	E

Figure 3: Schematic of Cat. No. 210159 Series Instruments.



NOTES:

1. VOLTAGE TP3 TO TP2 IS 6.0 VDC
2. R1, R4 AND R11 ARE CUSTOM RESISTOR NETWORKS
3. ALL RESISTORS ARE 5% 1/4 WATT UNLESS NOTED
4. ALL 1% OR BETTER RESISTORS ARE RN55D UNLESS NOTED
5. Q1 IS FITTED WITH A PN1716! HEATSINK
6. DS1 AND M1 ARE NOT PART OF THE PC ASSEMBLY
7. ALL CAPACITORS ARE IN mfd/VOLTS UNLESS NOTED
8. ALL CAPACITORS IN pfd ARE 1KV
9. BERG CONNECTORS PIN NO'S ARE AS SHOWN BELOW VIEWED FROM WIRE END.

CATALOG NO	DESCRIPTION	POWER SOURCE CIRCUIT
210160	HAND CRANK GENERATOR	A

SEE 5V-210159 SHT 2 FOR POWER SOURCE

Figure 4: Schematic of Cat. No. 210160 Series Instruments.

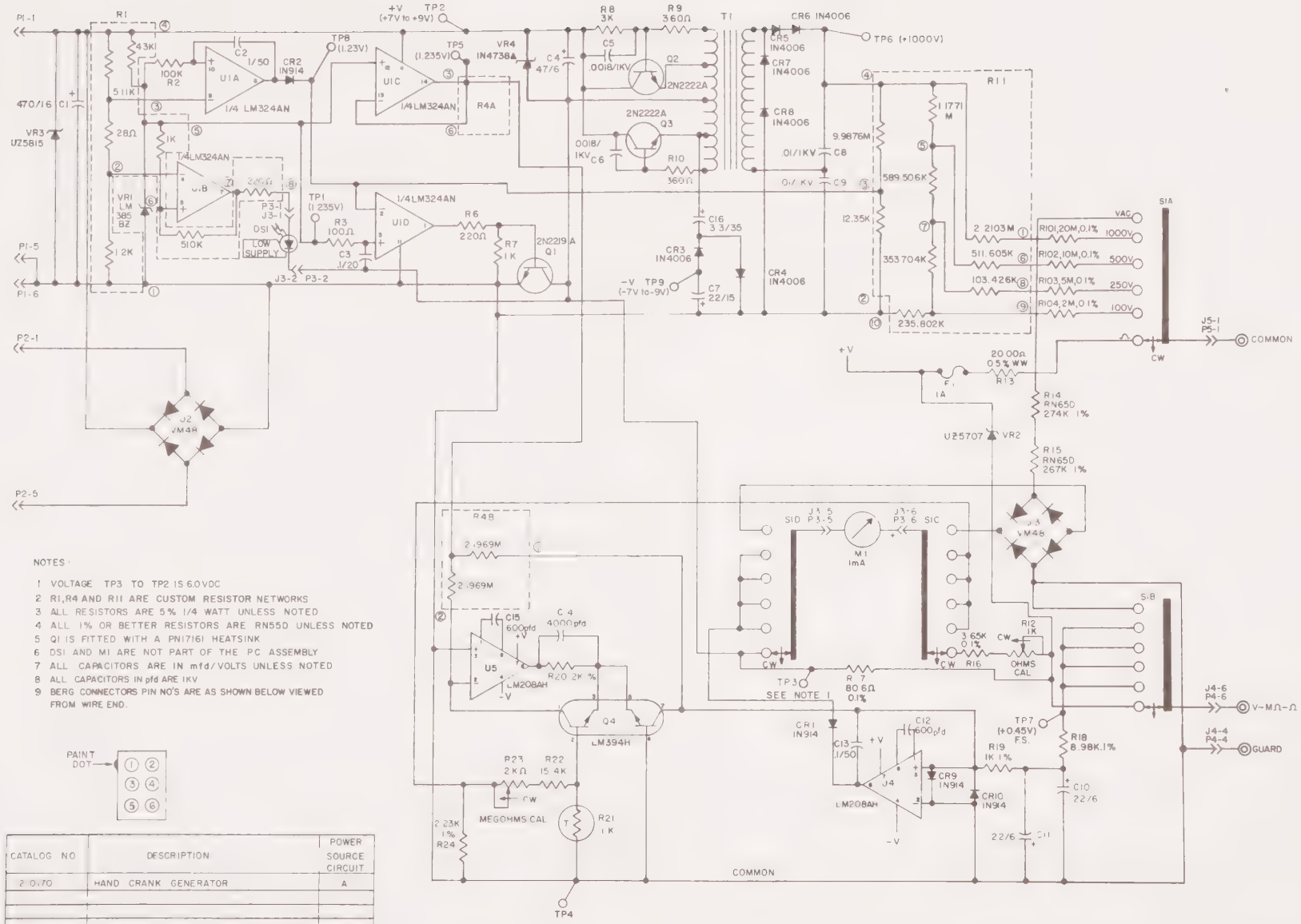


Figure 5: Schematic of Cat. No. 210170 Series Instruments.

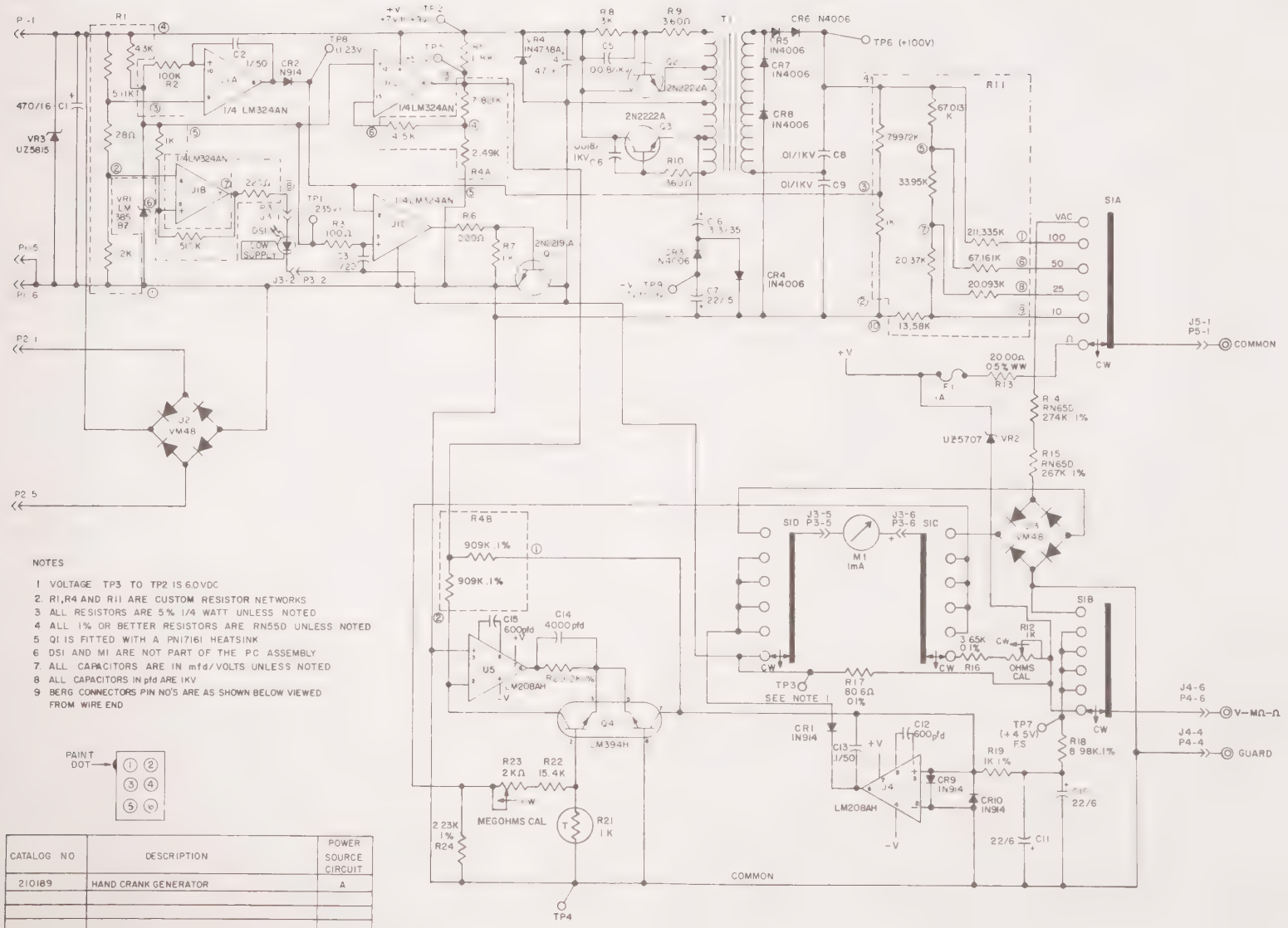


Figure 6: Schematic of Cat. No. 210189 Series Instruments.

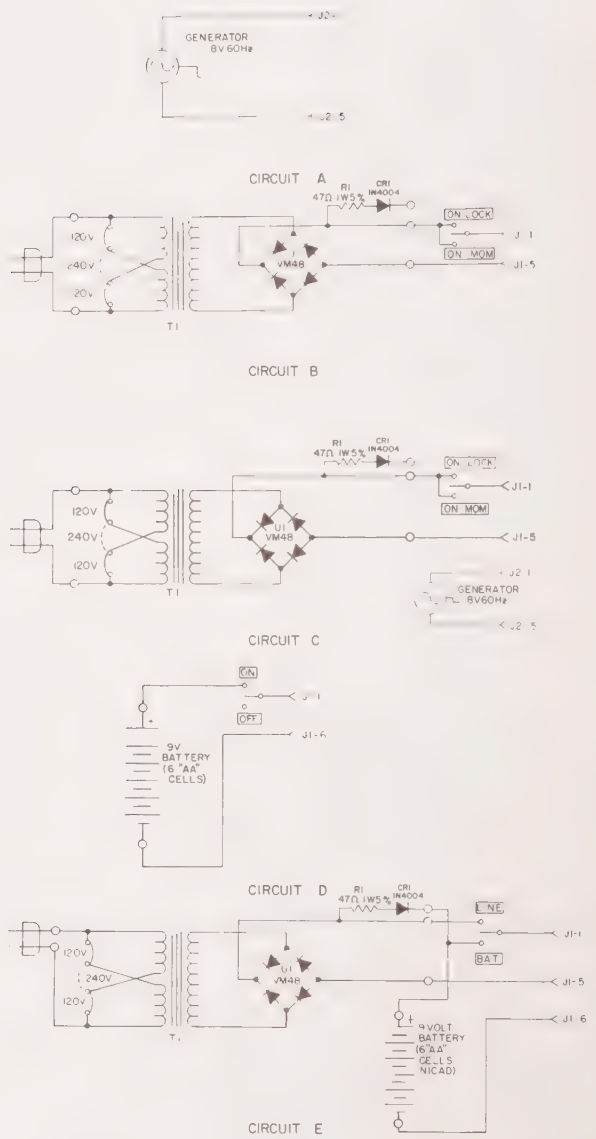


Figure 7: Schematic of Power Sources for MAJOR MEGGER Instruments.

TROUBLESHOOTING GUIDE

A. SIMPLIFIED TROUBLESHOOTING GUIDE FOR MAJOR MEGGER INSTRUMENTS

Before beginning this procedure, verify the complaint. Check that the batteries are not discharged or installed in reverse.

Perform the following steps and note the results, then consult the chart to find the probable cause of the failure.

Step 1. Set the MEGGER tester to the Ω position with no connections made; energize the MEGGER tester; the meter should read ∞ .

Step 2. Connect a short circuit between V-MΩ-Ω and COMMON. Energize the MEGGER tester; the meter should read 0.

Step 3. Maintain the short circuit, switch the MEGGER tester to the four MΩ positions; the meter should read 0 in all cases.

Step 4. Remove the short and repeat Step 3; the meter should read ∞ in all cases.

Step 5. Set the MEGGER tester to Discharge/Volts; the meter should read 0.

Step 6. Connect an AC voltage source of 300 to 600 volts between the V-MΩ - Ω and COMMON terminals. Connect the V-MΩ - Ω terminal to the high side. The meter should read the same as a standard voltmeter within ±3%.

TROUBLESHOOTING GUIDE (cont'd)

Step Numbers	Meter Indication	Remedy
1, 4, 5	Incorrect but constant mechanical position error	Reset the mechanical zero and retest. The case may be opened by removing four screws located in the bottom of the case to gain access to the inside of unit. High voltage may be present, BE CAREFUL!
2	Infinity	Check F1. Located inside case. **WARNING - For continued protection against fire, replace fuse only with 250V, 1A, fast acting type (AGC-1).**
2,3,6	Infinity on Ω and MΩ and zero on VOLTS.	Check the wiring to the meter. Check the wiring to the output leads. Check the meter. Check the leads.
2,3	Infinity.	Be sure that power source is properly energized. Check wiring to power source.
3	Infinity.	Check switch wiring.
2	Slightly left or right of zero.	Reset Ω Cal (R12). See Figure 13.

Step Numbers	Meter Indication	Remedy
3	Slight left or right of zero.	Reset Ω Cal (R23). See Figure 13.
2,3,6	All readings high or low.	Check M1 for calibration.
6	Low	Check U3, R14, R15.
6	High	Check R14, R15.
3	On wrong range	Check R11 and switch wiring.

If all the above simplified tests fail to correct the problem we recommend that the unit be returned to BIDDLE Instruments for repair. If this is not possible, the unit may be repaired on a sub-assembly basis. See Figures 8 thru 15 for sub-assembly part numbers and identification. Because the P.C. board can be easily damaged when repairs are attempted without proper experience or tools, it is highly recommended that it be returned to the factory for repair as a complete sub-assembly.

CAUTION! Use care in the removal of the 4 nuts that secure the circuit board or the plastic posts may be broken. Do not overtighten when replacing.

B. MORE COMPLETE TROUBLESHOOTING FOR MEGGER TESTERS SERIES

This procedure assumes that the Simplified Procedure has been attempted and has not corrected the problem. For this procedure the unit must be disassembled and unless noted, all interconnections must be made. See Figures 3 thru 15. Again, repair of the P.C. board is not recommended, unless proper skilled tools are available.

In order to perform this procedure the following equipment will be necessary:

A voltmeter capable of indicating from 1 to 1000 volts with at least 0.5% accuracy and with an input impedance of 10 MΩ.

A DC voltage source capable of supplying between 7 and 9 volts at 250 mA, a 100Ω 1% resistor, an ohmmeter capable of measuring between 500KΩ and 1 MΩ with a source voltage of at least 6 volts.

TABLE 3: OUTPUT VOLTAGE TEST LIMITS

SERIES	MAX. RATED VOLTAGE	TEST LIMITS	
		HIGH	LOW
210159	1000	835	801
210160	500	457	443
210170	1000	324	296
210189	100	99	96.5

Procedure

Step 1: If the unit is equipped with line/mains power or battery power options, remove the plug (P1) from the bottom of the board. Set function switch to 1000V MΩ X2. Connect the positive side of C1 (TP2) to the DC power supply. Connect the negative side of the power supply to the negative side of C1 (TP4) Set the voltmeter range switch to measure the maximum rated voltage. Connect the voltmeter to the V-MΩ - Ω and COMMON terminals. Energize the DC power supply. If the unit was totally non-functioning and now operates, CHECK THE POWER SOURCES WITH WHICH IT IS SUPPLIED. If the Voltmeter indicates 0 volts go to Step 2.

If the voltmeter indicates more than the High Limit, go to Step 8. (See Table 4.)
If the voltmeter indicates between the High and Low Limits and the MEGGER tester indicates 10MΩ , go to Step 15.
If the MEGGER tester indicates less than 10MΩ, go to Step 14.
If the voltmeter indicates less than the Low Limit CHECK AND REPLACE IF NECESSARY; CR5, CR6, CR7, CR8, C8, C9 (voltage doubler).

Step 2: Set the Function switch to Ω and the voltmeter to measure 6 volts. Energize the DC supply . Connect the voltmeter between TP2 and TP3. If the voltmeter reads 6 ±2% CHECK, AND REPLACE IF NECESSARY, R11 AND THE SWITCH WIRING.
If the Voltmeter reads greater than 6 volts, go to Step 3.
If the voltmeter reads less than 6 volts, go to Step 4.

Step 3: Set the voltmeter to read the maximum voltage. Connect the voltmeter between TP6 and TP4. Energize the DC supply. If the meter reads more than the maximum rated voltage CHECK, AND REPLACE IF NECESSARY, R11, THE SWITCH WIRING AND THE HIGH VOLTAGE JUMPER.

If the voltmeter reads 0V, REPAIR THE DC TO DC CONVERTER, IF NECESSARY. NOTE: The converter whines slightly when working properly.
If the voltmeter reads above 0V but less than 10% of rated voltage, CHECK, AND REPLACE, IF NECESSARY, R11 AND THE SWITCH WIRING.

Step 4: Connect the voltmeter between TP1 and TP4. Energize the DC supply. If the voltage is 1.235V ±1%, go to Step 5.
If the voltage is less than 1.235V, CHECK AND REPLACE, IF NECESSARY, VR1 AND R1.

Step 5: Connect the voltmeter between TP8 and TP4.
If the voltage is greater than 1.235V, go to Step 6.
If the voltage is less than 1.235V, go to Step 7.

Step 6: Connect the voltmeter between pin 3 of R1 and TP4.
If the voltage is greater than 1.235V, CHECK AND REPLACE, IF NECESSARY, C1, C2 AND CR2.
If the voltage is less than 1.235V, CHECK THE DC POWER SUPPLY VOLTAGE AND R1.

Step 7: Connect the voltmeter between the base of Q1 and TP4; if the voltage is greater than 0.6V, CHECK AND REPLACE Q1 IF NECESSARY.
If the voltage is less than 0.6V, CHECK AND REPLACE, IF NECESSARY, R6, R7, U1, Q1.

Step 8: Connect the voltmeter between TP6 and TP4. If the voltage is the maximum rated voltage within ±10%, the voltmeter may have more than 10MΩ input impedance CHECK AND REPLACE R11, IF NECESSARY.
If the voltage is greater than maximum rated voltage, go to Step 9.
If the voltage is less than maximum rated voltage, CHECK AND REPLACE, R11 IF NECESSARY.

Step 9: Connect the voltmeter between TP8 and TP4.
If the voltage is 1.235V ±1% or less, CHECK AND REPLACE, R11 IF NECESSARY.
If the voltage is greater than 1.235V, go to Step 10.

Step 10: Connect the voltmeter between TP1 and TP4. If the voltage is greater than 1.235V CHECK AND REPLACE VR1 IF NECESSARY.
If the voltage is 1.235V ±1%, go to Step 11.

Step 11: Connect the voltmeter between the output of U1D (pin 1) and TP4; if the voltage is greater than 1 volt, CHECK AND REPLACE U1 IF NECESSARY.
If the voltage is less than 1 volt, CHECK AND REPLACE, IF NECESSARY, Q1, R6, R7.

Step 12: Connect a jumper between the V-MΩ - Ω and COMMON terminals. If the MEGGER tester indicates 0MΩ, go to Step 13.
If the MEGGER tester indicates left of zero, ADJUST MEGOHMS CAL, R23 FOR ZERO READING.

Step 13: Keep the jumper in place. Connect the voltmeter between TP7 and TP4. If the voltmeter indicates 4.5V ±1% (210170 model 0.45V ±1%) the log converter is faulty. This complex circuit is composed of the following major parts: U4, U5, Q4, R4, R21, R23, as

well as other scaling and filtering components. The repair of the log converter goes beyond the scope of this procedure. Return the unit to the factory.

If the voltage is other than 4.5 V, (210170 model 0.45V) CHECK AND REPLACE, IF NECESSARY, R11, R18, R19, C10, C16.

Step 14: Connect a jumper between the V-MΩ-Ω and COMMON terminals of the MEGGER tester. If the MEGGER tester indicates 0MΩ, go to Step 13.
If the MEGGER tester indicates to the right of 0MΩ, REZERO USING MEGOHMS CAL, R23.
If the MEGGER tester indicates left of 0, go to Step 13.

Step 15: Set the Function switch to Ω and the voltmeter to measure 6 volts.
Connect the meter between the V-MΩ-Ω and COMMON terminals of the MEGGER tester.
If the voltmeter indicates 0 volts, CHECK AND REPLACE IF NECESSARY F1, R13, VR2, and the switch wiring.

If the voltmeter indicates 6 volts and the MEGGER indicates less than ∞ ohms, CHECK VR2 for leakage and REPLACE IF NECESSARY.

If the voltmeter indicates 6 volts and the MEGGER tester indicates ∞, go to Step 17.

If the voltmeter indicates 6 volts and the MEGGER tester indicates to the left of ∞, go to Step 16.

Step 16: Deenergize the power supply. The MEGGER tester should indicate ∞ megohms, 0 volts. Use the

mechanical zero on the meter movement to set this reading and repeat the test.

Step 17: Connect a jumper between the V-MΩ -Ω and COMMON terminals.
If the MEGGER tester indicates 0 ohms, go to Step 18.
If the MEGGER tester indicates other than 0, REZERO USING OHMS CAL R13 and retest.

Step 18: Connect a 100Ω resistor between the V-MΩ - Ω and COMMON terminals.
If the MEGGER tester reads 100Ω, go to Step 19.
If the MEGGER tester does not read 100Ω, CHECK AND REPLACE, IF NECESSARY, R12, R13, R16, R17 and UR2.

Step 19: Set the MEGGER tester to DISCHARGE/VOLTS range and measure the resistance between the V-MΩ - Ω and COMMON terminals. If the resistance is between 500KΩ and 115MΩ, go to Step 20.
If the resistance is less than 500KΩ, CHECK AND REPLACE, IF NECESSARY, R14, R15, U3, M1 AND THE SWITCH WIRING.

Step 20: Connect an AC voltage source of an accurately known voltage of between 300 & 600 Vrms between the V-MΩ - Ω and COMMON terminals. If the MEGGER tester indicates improperly, CHECK AND REPLACE, IF NECESSARY, R14, R15, U3.

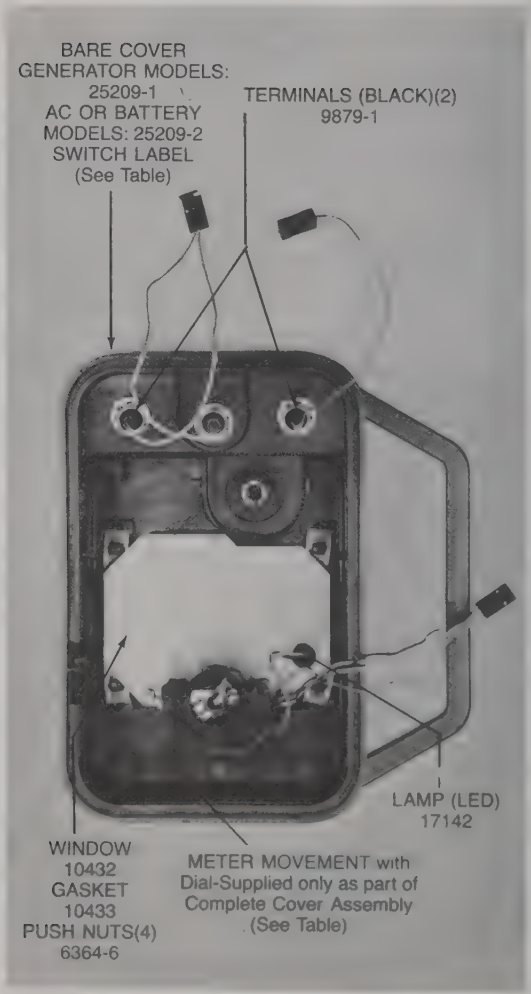


Figure 8: Replacement Parts for All Models

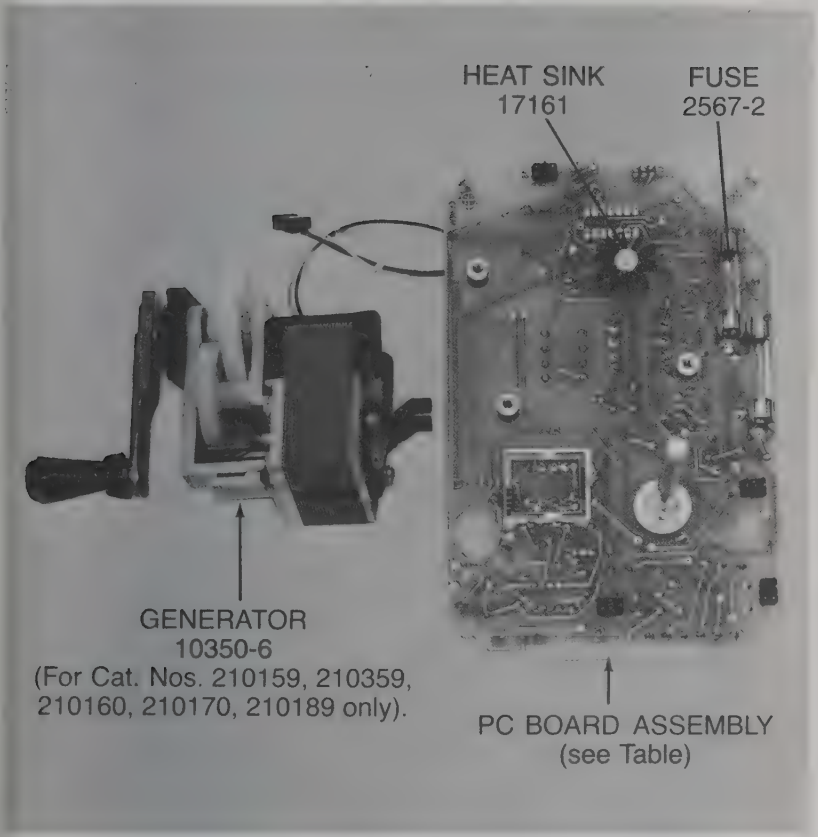


Figure 9: Replacement Parts for All Models

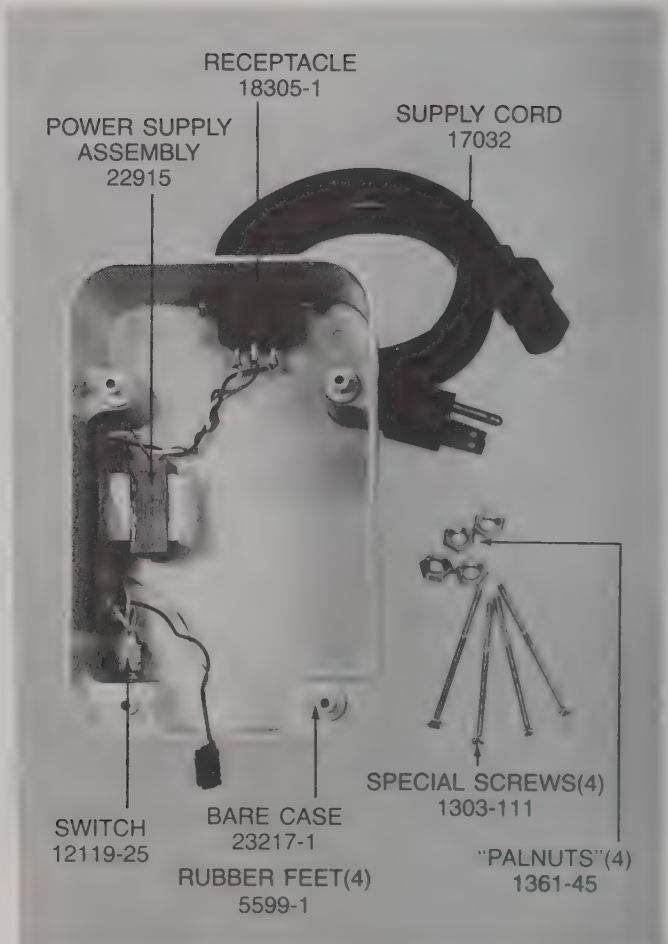


Figure 10: Replacement Parts for Cat. Nos. 210259 and 210359.

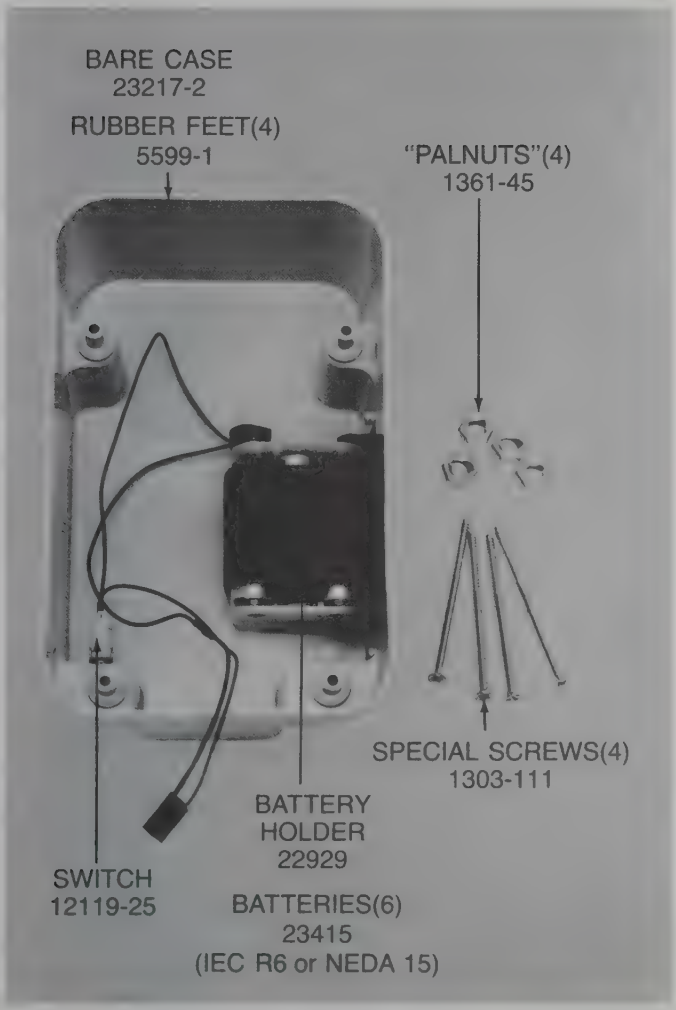


Figure 11: Replacement Parts for Cat. No. 210459.

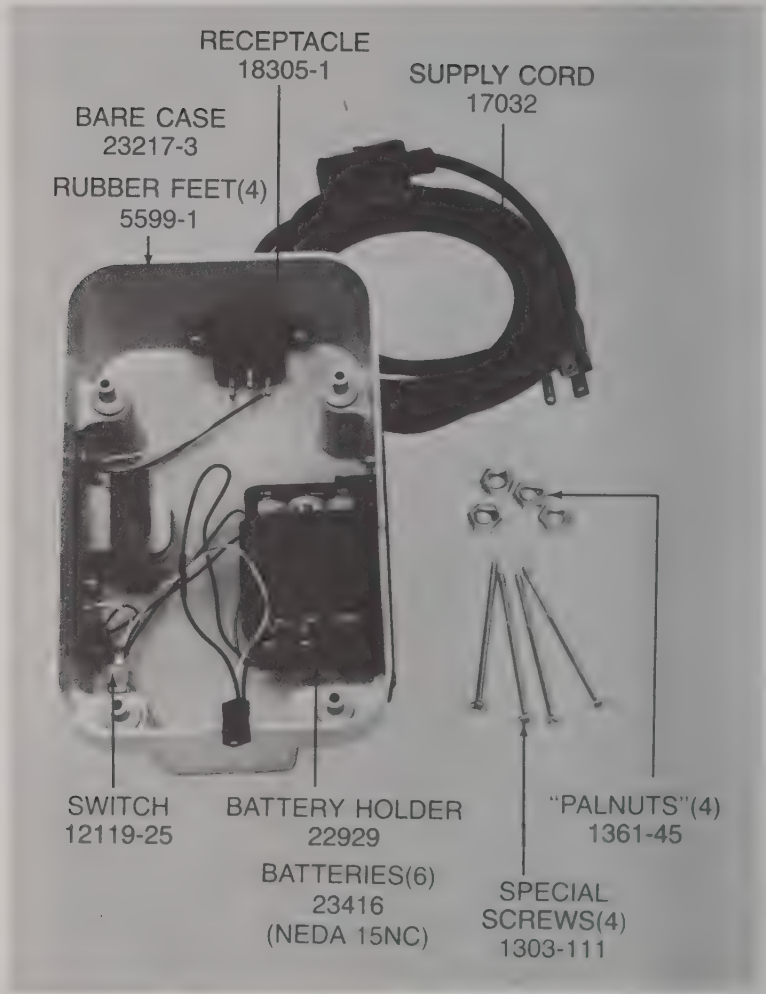


Figure 12: Replacement Parts for Cat. No. 210559.

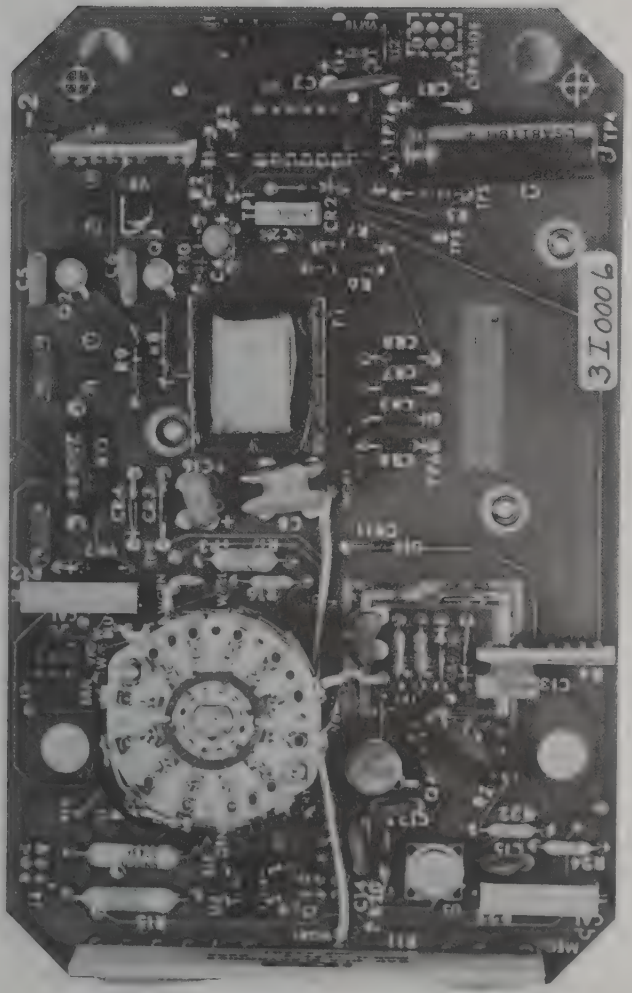


Figure 13: PC Board Assembly-Part Nos. 23210, 23210-2, 23210-3.

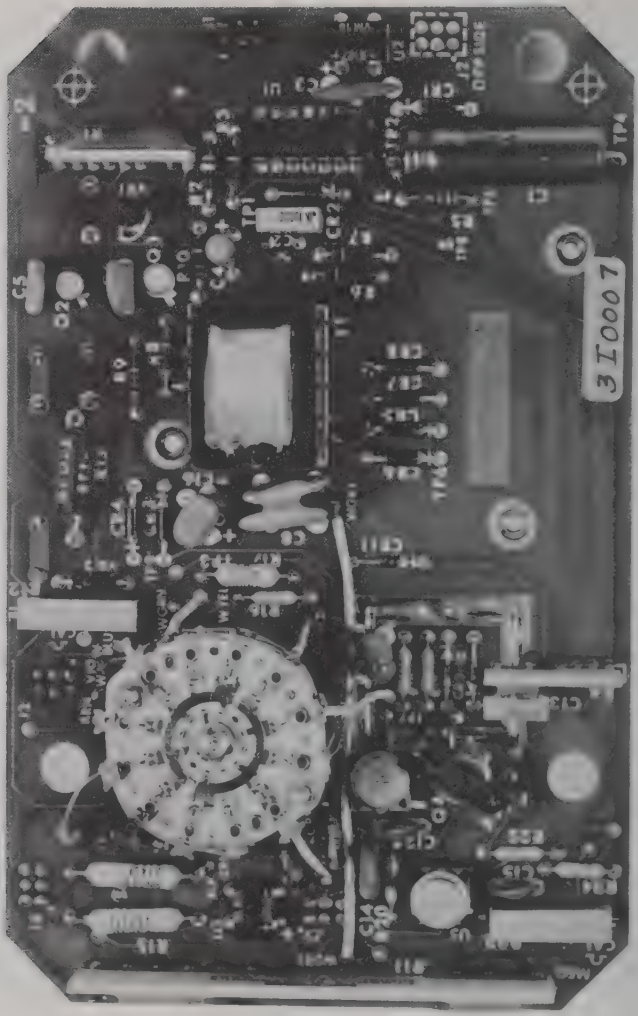


Figure 14: PC Board Assembly-Part No. 23210-1

Figure 15: Tabulation of Replacement Part Numbers

CATALOG NUMBER	COVER ASSEMBLY	LABEL	*METER MOVEMENT	P.C. BOARD ASSEMBLY
210159	22911-1	4494-14	23206	23210
210259	22911-2	4494-17	23206	23210
210359	22911-1	4494-18	23206	23210
210459	22911-2	4494-19	23206	23210
210559	22911-2	4494-20	23206	23210
210160	22911-4	4494-15	23206	23210-2
210170	22911-3	4494-21	23206-1	23210-1
210189	22911-5	4494-16	23206-2	23210-3

* Only supplied with complete cover assembly.

Section M
PREPARATION FOR STORAGE AND RESHIPMENT

Preparation for Storage

Place the MAJOR MEGGER Instrument in the carrying case along with test leads. Pack in a carton or box with adequate dunnage in accordance with best commercial practice (ASTM D 3951-82). Seal container with waterproof tape. Store container in a clean dry place. Storage temperature should not exceed the range of minus 55°C to plus 60°C.

For battery-powered models, be sure to remove dry batteries before long-term storage!

Preparation for Reshipment

Place the MAJOR MEGGER instrument in the carrying case along with test leads. Pack in a carton or box with adequate dunnage in accordance with best commercial practice (ASTM D 3951-82). Seal container with waterproof tape.

PARTS LIST

SYMBOL	DESCRIPTION	BIDDLE P/N	MFR	FSCM	MFR P/N
C1	Capacitor, 470μF/16V	23212-1	Sprague	56289	500D477H016DF5
C2	Capacitor, 0.1μF/50V	19836-2	Sprague	56289	LP7S1A104K
C3	Capacitor, 0.1μF/20V	19865-15	Centralab	71590	UK20-104
C4	Capacitor, 47μF/6V	17132-14	Sprague	56289	196D476X9006JE3
C5	Capacitor, 1800pF/1kV	7915-15	Centralab	71590	DD182
C6	Capacitor, 180pF/1kV	7915-15	Centralab	71590	DD182
C7	Capacitor, 22μF/15V	17132-15	Sprague	56289	196D226X9015KA1
C8-9	Capacitor, .001/1kV	7950-2	Centralab	71590	DD1032
C10-11	Capacitor, 22μF/6V	17132-16	Sprague	56289	196D226X9006JA1
C12	Capacitor, 600pF/1kV	7950-1	Centralab	71590	DD601
C13	Capacitor, 0.1μF/50V	19836-2	Sprague	56289	LP7S1A104K
C14	Capacitor, 4000pF/1kV	7950-6	Centralab	71590	DD402
C15	Capacitor, 600pF/1kV	7950-1	Centralab	71590	DD601
C16	Capacitor, 3.3μF/35V	17132-9	Sprague	56289	196D335X9035JA1
CR1-2	Diode, 75V/75mA	11637-6	Texas Inst	01925	1N914
CR3-8	Rectifier, 800V/1A	11637-36	Motorola	04713	1N4006
CR9-10	Diode, 75V/75mA	11637-6	Texas Inst	01925	1N914
R1	Resistor Network	23209	Caddock	19647	T1794-122
R2	Resistor, 100K, 5%	4501-91	Ohmite	44655	-
R3	Resistor, 100Ω, 5%	4501-86	Ohmite	44655	-
R4	Resistor Network	23208	Caddock	19647	T1794-121
R5	Resistor, 1.8K, 5%	4501-533	Ohmite	44655	-
R6	Resistor, 220Ω, 5%	4501-98	Ohmite	44655	-
R7	Resistor, 1K, 5%	4501-51	Ohmite	44655	-
R8	Resistor, 3.01K, 1%	12398-146	IRC	59993	Type RN55
R9-10	Resistor, 365Ω, 1%	12398-35	IRC	59993	Type RN55
R11	Resistor Network	23207	Caddock	19647	T1786-4
R12	Resistor Trimmer 1K	12340-7	Beckman	73138	Type 89X
R13	Resistor,20Ω, 0.5%, .3W	10027-115	Tel-Labs	94322	Type SA1
R14	Resistor, 274K, 0.1%, 1W	11445-100	IRC	59993	Type CEC-T0
R15	Resistor, 267K, 0.1%, 1W	11445-101	IRC	59993	Type CEC-TO
R16	Resistor, 3.65K, 1.0%	12398-172	IRC	59993	Type RN55
R17	Resistor, 80.6, 1.0%	12026-146	IRC	59993	Type RN60
R18	Resistor, 8.98K, 0.1%	12398-168	IRC	59993	Type RN55
R19	Resistor, 1K, 1.0%	12398-16	IRC	59993	Type RN55
R20	Resistor, 2K, 1.0%	12398-3	IRC	59993	Type RN55
R21	Resistor,1K,Temp Comp	23423	Tel-Labs	94322	Type Q81
R22	Resistor, 15.4K, 1.0%	12398-167	IRC	59993	RN55
R23	Resistor,Trimmer,2K,.75W	12340-8	Beckman	73138	Type 88X
R24	Resistor, 2.23K, 0.1%	12398-169	IRC	59993	Type RN55

All Resistors are 1/4W unless noted.

PARTS LIST

SYMBOL	DESCRIPTION	BIDDLE P/N	MFR	FSCM	MFG. P/N
U1	Quad Op Amp	23067	Nat. Semi	27014	LM324AN
U2-3	Diode Bridge, 400V	22921	Varo Semi	62703	VM48
U4-5	Op Amp	16473	Nat. Semi	27014	LM208AH
Q1	Transistor, NPN	11638-53	Motorola	04713	2N2219A
Q2-3	Transistor, NPN	11638-51	Motorola	04713	2N2222A
Q4	Transistor Pair, NPN	11638-70	Nat. Semi	27014	LM394H
VR1	Band Gap,1.2V	23066	Nat. Semi	27014	LM385BZ-1.2
VR2	Zener, 12V, 5W	12074-20	Unitrode	8S361	UZ5712
VR3	Zener, 15V, 5W	12074-6	Unitrode	8S361	UZ5715
VR4	Zener, 8.2V, 1W	4437-10	Motorola	04713	1N4738A
T1	Transformer	22780	Biddle	07239	22780
S1	Rotary Switch	23414	Biddle	07239	23414
F1	Fuse .5A, 250V	2567-2	Buss	71400	Type AGC
J1-5	Jack	22931	Berg Elec	22526	65610-406
PCB	Circuit Board	23210	Biddle	07239	23210
-	Fuse Clips	19852-1	Littlefuse	75915	102071
-	Spacers	23385-1	Bivar	32559	312-250
		23385-3	Bivar	32559	315-400
		23385-7	Bivar	32559	120-156
		23385-8	Bivar	32559	508-075
		23412-5	Penn Eng.	46384	KFB3-632-6
		23412-2	Penn Eng.	46384	KFB3-632-9

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